AMENDMENTS TO THE CLAIMS

1. (original) An array of electro-magnetically actuated MEMS devices, each device comprising:

a mirror having a reflective surface;

a gimbal structure for movably supporting said mirror about first and second axes;

a first coil pair on the mirror for causing selective movement of said mirror about the first axis in the presence of a magnetic field; and

a second coil pair on the mirror for causing selective movement of said mirror about the second axis in the presence of a magnetic field,

each of said first and second coil pairs substantially filling the area of the mirror covered by the reflective surface.

2. (original) The array of Claim 1 wherein the first and second coil pairs are superposed on said mirror and are separated by a dielectric layer.

3. (original) The array of Claim 1 wherein the coils of the first coil pair are wound in opposite directions from each other, and wherein the coils of the second coil pair are wound in opposite directions from each other.

4. (original) The array of Claim 1 wherein the coils of the first coil pair are positioned on different sides of said first axis, and wherein the coils of the second coil pair are positioned on different sides of said second axis.

5. (original) The array of Claim 1 wherein the magnetic field is applied by an array of magnets of alternating polarity.

6. (original) The array of Claim 5 wherein one or more of said magnets are associated with each one of said devices.

7. (original) The array of Claim 5 wherein said magnets are arranged in a checkerboard pattern of alternating north and south poles.

8. (original) The array of Claim 5 wherein said magnets include a first set of magnets having poles perpendicular to a plane on which said array of MEMS devices is arranged, and a second set of magnets having poles parallel to said plane, and wherein said magnets of said first set are arranged between magnets of said second set.

9. (original) The array of Claim 1 wherein each device further comprises a feedback mechanism for determining the angular deflection of a respective mirror about one of said axes .

10. (original) The array of Claim 9 wherein said feedback mechanism comprises an excitation coil fixed relative to the device and a detection circuit for sensing the relative proximity of one of said coils to said excitation coil.

11. (original) The array of Claim 1 wherein the reflective surface is on an opposite side of said mirror from said coil pairs.

12. (original) A magnetically actuated mirror array apparatus, comprising:

an array of electro-magnetically actuated MEMS devices, each device comprising: a mirror having a reflective surface; a gimbal structure for movably supporting said mirror about first and second axes; a first coil pair on the mirror for causing selective movement of said mirror about the first axis in the presence of a magnetic field; and a second coil pair on the mirror for causing selective movement of said mirror about the second axis in the presence of a magnetic field, each of said first

and second coil pairs substantially filling the area of the mirror covered by the reflective surface; and

an array of magnets positioned proximate said array of MEMS devices for applying the magnetic field, each magnet of said array being associated with one or more of said mirror devices.

13. (original) The apparatus of Claim 12 wherein said magnets are arranged in a checkerboard pattern of alternating north and south poles.

14. (original) The apparatus of Claim 12 wherein said magnets include a first set of magnets having poles perpendicular to a plane on which said array of MEMS devices is arranged, and a second set of magnets having poles parallel to said plane, and wherein said magnets of said first set are arranged between magnets of said second set.

15. (original) The apparatus of Claim 12 wherein each device further comprises a feedback mechanism for determining the angular deflection of a respective mirror about one of said axes .

16. (original) The apparatus of Claim 15 wherein said feedback mechanism comprises an excitation coil fixed relative to said device and a detection circuit for sensing the relative proximity of one of said coils to said excitation coil.

17. (original) The apparatus of Claim 12 wherein said reflective surface is on a side of said mirror opposite said coil pairs.

18. (original) A magnetically actuated mirror array apparatus, comprising:

an array of mirror devices generally arranged in a plane, each mirror device comprising: a mirror; a gimbal structure for movably supporting said mirror about first

and second axes; and actuation coils for causing selective movement of said mirror about the first and second axes; and

an array of magnets generally arranged in a plane proximate and parallel to said plane of said mirror device array, with each magnet being associated with one or more of said mirror devices.

19. (original) The apparatus of Claim 18 wherein said magnets are arranged in a checkerboard pattern of alternating north and south poles.

20. (original) The apparatus of Claim 18 wherein said magnets include a first set of magnets having poles perpendicular to the plane of said mirror device array, and a second set of magnets having poles parallel to said plane of said mirror device array, and wherein said magnets of said first set are arranged between magnets of said second set.

21. (original) The apparatus of Claim 18 wherein each device further comprises a feedback mechanism for determining the angular deflection of a respective mirror about one of said axes .

22. (original) The apparatus of Claim 21 wherein said feedback mechanism comprises an excitation coil and a detection circuit for sensing the relative proximity of one of said coils to said excitation coil.

23. (original) A MEMS apparatus comprising:

an array of electromagnetically actuated MEMS devices arranged in rows on a substrate; and

an array of magnets positioned along a plane parallel to said substrate, said array of magnets including magnets along each row of devices having a pole direction parallel to said substrate, and magnets between each row of devices having a pole

direction perpendicular to said substrate such that said devices are within a magnetic field produced by said array of magnets.

24. (original) The apparatus of Claim 23 wherein said MEMS devices each comprise:

a mirror having a reflective surface;

a gimbal structure for movably supporting said mirror about first and second axes;

a first coil pair on the mirror for causing selective movement of said mirror about the first axis in the presence of the magnetic field; and

a second coil pair on the mirror for causing selective movement of said mirror about the second axis in the presence of the magnetic field,

each of said first and second coil pairs substantially filling the area of the mirror covered by the reflective surface.

25. (original) The apparatus of Claim 24 wherein said reflective surface is on a side of said mirror opposite said coil pairs.

26. (original) An array of electromagnetically actuated MEMS devices, comprising:

an array of MEMS devices arranged in rows and columns, each device comprising at least two coils paired together on a single circuit with each coil being wound in opposite directions and being positioned each on a different side of a rotational axis of the device, the coils together filling an available surface area; and

an array of magnets of alternating polarities positioned in a plane parallel to a plane containing said array of MEMS devices such that each such device is within a magnetic field containing primarily field lines perpendicular to the plane of said array of MEMS devices.

27. (withdrawn) A MEMS mirror array package, comprising:

an array of magnets; and

an array of electro-magnetically actuated MEMS mirror devices spaced apart from and generally superposed on said array of magnets,

said array of magnets and said array of magnetically actuated MEMS mirror devices being adjustably assembled relative to each other.

28. (withdrawn) The package of Claim 27 further comprising a support plate on which said array of magnets is adjustably mounted.

29. (currently amended) The package of Claim 28 ~~26~~ wherein said array of magnets is adjustably mounted on said support plate using a plurality of alignment screws.

30. (withdrawn) The package of Claim 28 wherein said array of magnets is adjustably mounted on said support plate using springs and opposing set screws.

31. (withdrawn) The package of Claim 27 further comprising a spacer between said array of electro-magnetically actuated MEMS mirror devices and said array of magnets.

32. (withdrawn) The package of Claim 27 further comprising a circuit board attached to said array of electro-magnetically actuated MEMS mirror devices.

33. (withdrawn) The package of Claim 27 further comprising a window for passage of optical signals therethrough on a side of said array of electro-magnetically actuated MEMS mirror devices opposite said array of magnets.

34. (withdrawn) A magnetically actuated mirror array apparatus, comprising:

an array of magnetically actuated mirror devices, each including a selectively movable mirror;

an array of magnets positioned proximate said array of magnetically actuated mirror devices, each magnet in said array of magnets associated with one or more of said mirror devices;

a substrate supporting said array of magnetically actuated mirror devices and providing electrical connections to said magnetically actuated devices; and

a window for transmission therethrough of optical beams to and from said mirrors.

35. (withdrawn) A feedback mechanism for determining angular deflection of a mirror about an axis in a magnetically actuated mirror device, the mirror device including a pair of coils on the mirror for rotating the mirror about the axis, the feedback mechanism comprising an excitation coil and a detection circuit for sensing the relative proximity of said coils to said excitation coil.

36. (withdrawn) The feedback mechanism of Claim 35 wherein said excitation coil is driven with a high frequency current, and said detection circuit reads an output signal from said coils that is proportional to the proximity of said coils to said excitation circuit.

37. (withdrawn) The feedback mechanism of Claim 36 wherein said high frequency current is about 1 MHz or greater.

38. (withdrawn) The feedback mechanism of Claim 36 wherein said excitation coil is driven by a signal comprising a sequence of pulses or sinusoidal cycles.

39. (withdrawn) A feedback mechanism for determining angular deflection of a mirror about an axis in a magnetically actuated MEMS mirror device, the mirror device including a pair of actuation coils on the mirror for causing rotation of the mirror about the axis, each actuation coil being on a different side of said axis, the feedback mechanism comprising:

an excitation coil fixed relative said axis, said excitation coil driven with a high frequency current; and

means for detecting a signal from said excitation coil at said actuation coils, said signal having a strength proportional to the relative proximity of said coils to said excitation coil.

40. (withdrawn) The feedback mechanism of Claim 39 wherein said high frequency current is about 1 MHz or greater.

41. (withdrawn) The feedback mechanism of Claim 39 wherein said signal comprises a sequence of pulses or sinusoidal cycles.

42. (original) A magnetically actuated mirror array apparatus, comprising:

an array of mirror devices arranged in a plane, each mirror device comprising: a mirror; a gimbal structure for movably supporting said mirror about first and second axes; actuation coils for causing selective movement of said mirror about the first and second axes; and means for determining the angular deflection of said mirror about said axes; and

an array of magnets arranged in a plane proximate and parallel to said plane of said mirror device array, each magnet being associated with one or more of said mirror devices.

43. (withdrawn) A method for determining the angular deflection of a mirror about an axis in a magnetically actuated mirror device, the mirror device including a pair of coils on the mirror for rotating the mirror about the axis, the method comprising:

generating a drive signal at a position fixed relative to a structure movably supporting said mirror;

detecting an output signal responsive to said drive signal at one of said pair of coils; and

determining the angular deflection of said mirror based on the strength of said output signal.

44. (withdrawn) The method of Claim 43 wherein said drive signal has a frequency about 1 MHz or greater.

45. (withdrawn) The method of Claim 43 wherein said drive signal comprises a sequence of pulses or sinusoidal cycles.

46. (withdrawn) A method of fabricating a magnetically actuated mirror device, comprising:

forming multiple overlapping actuation coil layers on one side of a silicon on insulator substrate;

forming a gimbal structure on said substrate to define and movably support a mirror on which said coil layers are formed; and

forming a reflective surface on an opposite side of said substrate on said mirror.

47. (withdrawn) The method of Claim 46 wherein forming multiple overlapping actuation coil layers comprises depositing patterned conductive metal layers on said silicon on insulator substrate.

48. (withdrawn) The method of Claim 47 wherein said conductive metal layers are separated by a dielectric material.

49. (withdrawn) The method of Claim 47 wherein forming a reflective surface comprises depositing a layer of reflective material on said opposite side of said substrate.

50. (withdrawn) The method of Claim 49 wherein said reflective material comprises gold or titanium.

51. (withdrawn) A process of fabricating a magnetically actuated MEMS mirror device, comprising:

depositing multiple overlapping actuation coil layers on one side of a silicon on insulator substrate;

forming a gimbal frame on the substrate to rotatably support a structure on which said coil layers are deposited; and

forming a reflective surface on an opposite side of said substrate on said structure.

52. (withdrawn) The method of Claim 51 wherein depositing actuation coil layers comprises depositing patterned conductive metal layers on said silicon on insulator substrate.

53. (withdrawn) The method of Claim 52 wherein said conductive metal layers are separated by a dielectric material.

54. (withdrawn) The method of Claim 51 wherein forming a mirror comprises depositing a layer of reflective material on said opposite side of said substrate.

55. (withdrawn) The method of Claim 54 wherein said reflective material comprises gold or titanium.

56. (withdrawn) An apparatus for determining the angular deflection of a mirror about an axis in a magnetically actuated mirror device, the mirror device including a pair of coils on the mirror for rotating the mirror about the axis, the apparatus comprising:

means for generating a drive signal at a position fixed relative to a structure movably supporting said mirror;

means for detecting an output signal responsive to said drive signal at one of said pair of coils; and

means for determining the angular deflection of said mirror based on the strength of said output signal.

57. (withdrawn) The apparatus of Claim 56 wherein said drive signal has a frequency about 1 MHz or greater.

58. (withdrawn) The apparatus of Claim 56 wherein said drive signal comprises a sequence of pulses or sinusoidal cycles.

59. (original) An electro-magnetically actuated MEMS device, comprising:

a mirror having a reflective surface;

a gimbal structure for movably supporting said mirror about first and second axes;

a first coil pair on the mirror for causing selective movement of said mirror about the first axis in the presence of a magnetic field; and

a second coil pair on the mirror for causing selective movement of said mirror about the second axis in the presence of a magnetic field,

each of said first and second coil pairs substantially filling the area of the mirror covered by the reflective surface.

60. (original) The device of Claim 59 wherein the first and second coil pairs are superposed on said mirror and are separated by a dielectric layer.

61. (original) The device of Claim 59 wherein the coils of the first coil pair are wound in opposite directions from each other, and wherein the coils of the second coil pair are wound in opposite directions from each other.

62. (original) The device of Claim 59 wherein the coils of the first coil pair are positioned on different sides of said first axis, and wherein the coils of the second coil pair are positioned on different sides of said second axis.

63. (original) The device of Claim 59 wherein the magnetic field is applied by one or more external magnets.

64. (original) The device of Claim 59 further comprising a feedback mechanism for determining the angular deflection of the mirror about one of said axes .

65. (original) The device of Claim 64 wherein said feedback mechanism comprises an excitation coil fixed relative to the device and a detection circuit for sensing the relative proximity of one of said coils to said excitation coil.

66. (original) The device of Claim 59 wherein said reflective surface is on a side of said mirror opposite said coil pairs.

67. (original) An electro-magnetically actuated MEMS device, comprising:

a mirror having a reflective surface;

a gimbal frame for movably supporting said mirror about first and second axes;

a first coil on the mirror; and

a second coil on the gimbal frame, said first and second coils for causing selective movement of said mirror about the first and second axes in the presence of a magnetic field, said first coil substantially filling the area of the mirror covered by the reflective surface.

68. (original) The device of Claim 67 wherein the magnetic field is applied by one or more external magnets.

69. (original) An electro-magnetically actuated MEMS mirror array apparatus, comprising:

(a) an array of mirror devices, each comprising:

a mirror having a reflective surface;

a gimbal frame for movably supporting said mirror about first and second axes;

a first coil on the mirror; and

a second coil on the gimbal frame, said first and second coils for causing selective movement of said mirror about the first and second axes in the presence of a magnetic field, said first coil substantially filling the area of the mirror covered by the reflective surface; and

(b) an array of magnets positioned proximate said devices for applying the magnetic field, each magnet of said array being associated with one or more of said mirror devices.

70. (original) The apparatus of Claim 69 wherein said magnets include a first set of magnets having poles perpendicular to a plane on which said array of mirror devices is arranged, and a second set of magnets having poles parallel to said plane, and wherein said magnets of said first set are arranged between magnets of said second set.

71. (original) The apparatus of Claim 69 wherein said magnets have poles perpendicular to a plane on which said array of mirror devices is arranged.

72. (original) The apparatus of Claim 69 wherein said magnets have poles parallel to a plane on which said array of mirror devices is arranged.

73. (original) The array of Claim 1 wherein the reflective surface and said coil pairs are on the same side of said mirror with the reflective surface generally covering said coil pairs.

74. (original) The apparatus of Claim 12 wherein the reflective surface and said coil pairs are on the same side of said mirror with the reflective surface generally covering said coil pairs.

75. (original) The apparatus of Claim 24 wherein the reflective surface and said coil pairs are on the same side of said mirror with the reflective surface generally covering said coil pairs.

76. (withdrawn) A method of fabricating a magnetically actuated mirror device, comprising:

forming multiple overlapping actuation coil layers on one side of a silicon on insulator substrate;

forming a gimbal structure on said substrate to define and movably support a mirror on which said coil layers are formed; and

forming a reflective surface on said mirror substantially covering said coil layers.

77. (withdrawn) The method of Claim 76 wherein forming multiple overlapping actuation coil layers comprises depositing patterned conductive metal layers on said silicon on insulator substrate.

78. (withdrawn) The method of Claim 77 wherein said conductive metal layers are separated by a dielectric material.

79. (withdrawn) The method of Claim 77 wherein forming a reflective surface comprises depositing a layer of reflective material.

80. (withdrawn) The method of Claim 79 wherein said reflective material comprises gold or titanium.

81. (original) The device of Claim 67 wherein said first coil is on a side of said mirror opposite said reflective surface.

82. (original) The device of Claim 67 wherein the reflective surface and said first coil is on the same side of said mirror with the reflective surface generally covering said second coil.

83. (original) The apparatus of Claim 69 wherein said first coil is on a side of said mirror opposite said reflective surface.

84. (original) The apparatus of Claim 69 wherein the reflective surface and said first coil is on the same side of said mirror with the reflective surface generally covering said second coil.